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NUTRITIONAL ANEMIA IN FLORIDA

by

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During the past 12 years a study has been made of human dietary deficiencies occurring among the people of Florida. While isolated groups of college students, rural women, and city children have been examined, the chief objective of this investigation was to determine the prevalence of nutritional deficiency diseases in rural children. Special reference was given to nutritional anemia in relation to home-grown foods. At the present 10,000 subjects have been examined. More than three-fourths of them were rural school children, living in eight counties. Four of these counties were in the north and central parts of the State, three bordered the Gulf and one the Atlantic. A few of the people of the coastal counties were engaged in fishing and the production of citrus and truck crops, but general farming was the chief industry of the larger part of the population.

In the first years of the investigation practically all of the children in the eight grades were examined; later, the examination was limited to those in the first four grades. Dietary studies were made of 3,000 of the children.

The diets as a whole were very poor. None of the children had food that provided a wide margin of safety. About 25 percent had diets that could be rated as fair - not good, but passable. These were above the danger line but possibly were not far enough. The remainder of the group, about 75 percent, had diets deficient in one or more nutrients and were below the physiological danger line, according to conservative standards of nutrition. Among the entire group, milk was used in only 28 percent of the menus, butter and eggs in 30 percent, leafy vegetables in 27 percent, and fruit in only 20 percent. The cereals were represented al-

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most entirely by grits, corn meal, and white flour. The food items occurring most often were rice, grits, corn meal, sirup, white bacon, and biscuits. The year-round garden was rarely found and, outside the citrus section, fruit was scarce and limited to summer when wild berries and a few peaches and figs were available.

The data collected indicated that these deficient diets were affecting the health of the people. Approximately 33 percent of the children had some degree of conjunctivitis. This type of conjunctivitis was diagnosed by blood studies and further clinical examinations as a manifestation of a deficiency in vitamin A. Many of these subjects also had rough, scaly skin and dry hair which gave further indication of a lack of vitamin A. Later this diagnosis was confirmed by giving large doses of vitamin A to selected subjects. In a few weeks the gross symptoms of the deficiency disappeared and soon the blood picture returned to normal.

Carious teeth were found in about 45 percent of the subjects. In many cases the incisors were carious and the 6-year molars were decayed before the 12-year molars erupted. A more or less cursory examination was made of the teeth of mothers and expectant mothers. The entire absence of teeth, the absence of front teeth, the absence of molars, the presence of many carious teeth, and malocclusions all gave evidence of poor tooth structure, due for the most part to inadequate diets - perhaps inadequate calcium and phosphorus. It was found that 33 percent of the children using milk had teeth that were not defective, while little more than 10 percent of those not using milk had good teeth.

Another defect that apparently bore some relation to diet was abnormal height-age relations. It was found that the 8-year-old girl was $2\frac{1}{2}$ inches shorter than the standard given by Rose and 5 inches shorter than the standard given by Holt; the 13-year-old girl was 3 inches shorter than the standard of either authority. Similar observations were made of the boys. The 16-year-old boy was 3 inches under height by the standard of Rose and 4 inches by the standard of Holt.

Enlarged and diseased tonsils were found in approximately 40 percent of the children who had not had tonsillectomy. According to our observations, malnourished children often have defective tonsils. Moreover, the anemia, the chronic cold, and other nasal infections are still present in children who have had the tonsils removed.

But of all the defects found in these subjects, anemia was the most prevalent. Moreover, wide variations in the percentage of anemia were found in the children of the different counties and in different sections of the same county. The data in table 1 (page 3) show the grouping of 4,335 rural children according to hemoglobin values. All these children were attending school and were considered able to participate in the daily program. It is shown that 53 percent of them were anemic, that is, hemoglobin values were below 11.3 grams; 23 percent had border-line anemia, hemoglobin below 13.6 grams; approximately 10 percent had values between 3.6 and 8.2 grams; and only 23 percent had normal values. There was considerable variation in the percentage of anemia in the children of the different counties. County 3 had 28 percent anemia, while the other

counties had 63, 58, 46, 62, 42 and 42 percent respectively. In county 1 there were four times as many children in the lowest hemoglobin group as in the highest; in county 2, five times as many; and in county 3, six times as many. The blood of these children in the low-hemoglobin groups showed the characteristic reduction of hemoglobin and of cell size typical of microcytic hypochromic anemia. With severe involvement the erythrocytes appeared pale and were of all shapes and sizes; a few were macrocytes but the majority were smaller than the normal cell. The average erythrocyte count in the anemic children was around 3,500,000, although total counts of 2,700,000 were seen. The hemoglobin concentration in the most severely affected children examined was as low as 2.89 grams. The color index was below 1 - usually about 0.5 - and the volume index varied from 0.5 to 0.7.

TABLE 1.- Grouping of 4,335 children according to hemoglobin values

County	Number of children	Hemoglobin values						
		14.6 16.00 gm. 91-100 percent	13.6 14.4 gm. 85-90 percent	11.4 13.5 gm. 71-84 percent	9.8 11.3 gm. 61-70 percent	8.3 9.7 gm. 51-60 percent	3.6 8.2 gm. 21-50 percent	Anemia per-centage
1	766	22	100	160	230	157	97	63
2	900	21	124	224	269	151	111	58
3	361	50	80	129	68	26	8	28
4	530	135	38	112	122	92	31	46
5	528	24	63	112	130	120	79	62
6	420	40	40	88	110	82	60	60
7	520	52	120	125	100	97	26	42
8	310	40	68	70	20	70	42	42
	4,335	23 percent		23 percent		53 percent		

Other abnormal bodies were observed in the blood. These were almost colorless disks, veillike in appearance, 40 to 50 microns in diameter, with pink crescents in the margins. These bodies (corps en demilune) were considered nonspecific indicators of anemia.

The data given in table 2 show the percentage of anemic children as regards the incidence of hookworm and in relation to soil deficiencies as measured by nutritional diseases of cattle. Hookworm infection is a factor which in the past has been held to account for the high incidence of anemia in the South. From the data presented, this infection could not account for the observed variations. Hookworm was widespread and should have contributed more or less uniformly to the occurrence of anemia; yet in certain schools where a large number of children were infected there was no more anemia than in schools where a lower per centage of infections occurred. It was found also that many children with hemoglobin values between 21 and 50 percent were negative to hookworm.

It was observed often that the removal of the worm burden did not cause an improvement in hemoglobin, but on the other hand if iron were given

to hookworm-infected children the hemoglobin was restored to normal values without the removal of the parasites. Investigations on the degree of hookworm infection showed that many of the children were infected with a moderate number of parasites. It was found that a well nourished child thus parasitized had little change in hemoglobin; however, when a poorly nourished one had the same number of worms the hemoglobin reached dangerously low levels. Apparently most of the general symptoms considered indicative of hookworm infection were due to anemia, for when iron was given the pallor, the marked weakness, the excessive fatigue, loss of appetite, and edema gradually disappeared.

The fact that the welfare of livestock of any particular region was limited by the fertility of pasture soils has been recognized for many years. At the Florida Experiment Station it was demonstrated that the age-old disease of cattle known locally as "salt-sick" was a nutritional disease occurring when the food was restricted to native forages grown on certain white and gray sands and residual mucks. Inadequate quantities of iron, copper, cobalt, or combinations of these and perhaps other elements were found to be the underlying cause of the disease. Supplemental salt mixtures containing these elements raised the hemoglobin and increased growth and reproduction. There was a possibility that people living on these deficient soils and producing much of their food thereon would suffer from the same deficiencies. In former investigations it was noted that the incidence of anemia was usually highest in the schools where the predominant soils of the district were classed as deficient in regard to salt-sick of cattle.

TABLE 2.-Variation in the incidence of anemia and hookworm infection of children by districts in relation to salt-sick of cattle

County number	Number of schools	Number of children	Anemia percentage	Hookworm percentage	Soil in relation to salt-sick
1	6	408	76-89	55-75	deficient
	3	93	45-67	60-95	marginal
	1	265	32	65	protected to marginal
		766			
2	4	284	55-96	40-60	deficient
	2	254	33-47	35-50	marginal
	4	82	7-10	60-70	protected
		620			
3	4	95	52-60	30-50	deficient
	3	106	37-42	39-47	marginal
	10	159	0-23	0-80	protected
		360			
4	3	267	45-60	40-60	deficient to marginal
	4	264	20-39	59-70	protected to marginal
		531			
Totals	44	2,277			

The data show (table 2) that in those districts where the predominant soils were classed as deficient in regard to salt-sick of cattle from 52 to 96 percent of the children were anemic, but in the districts where the predominant soils were balanced and classed as protected in regard to salt-sick, from 0 to 23 percent were anemic.

It was found that the people of these counties could be divided into rather distinct groups according to food sources and food habits. These groups include families who, regardless of whether they live on protected or on deficient soil, obtain 70 percent of their food from the soil; and families who live on the less-productive - and usually deficient - soils, and obtain varying amounts of food therefrom.

On the more productive soils practically all the meat, eggs, milk, fruit, vegetables, and chickens were produced on the farm or obtained locally. Only such staples as sugar, coffee, flour, bread, rice, grits, and condiments were bought regularly.

As the soils became less productive, less food was raised and a greater percentage was bought. In some sections the soils were so unproductive that farming as a means of livelihood had been discontinued and the family head either worked by the day - usually on a Government relief project - or was on direct relief. The families living on such farms usually had a part-time garden and a few chickens and hogs, but because of low incomes, ignorance of food values, habit, etc., the diet was composed largely of the cheap foods - rice, grits, biscuit, sirup, and white bacon. By modern standards, the diet of this group was below the nutritional danger line in several particulars. With these families, as with those who raised a larger percentage of their food, the foods highest in iron were produced on the farm or nearby.

Thus, we have three groups: (1) Those families producing 70 percent of their food, which was fairly adequate both as to quantity and iron; (2) those producing enough food, but food that was low in iron and perhaps in other essential elements; and (3) those producing food inadquate both in quantity and quality and who, because of economic conditions, ignorance, and habit were subsisting on diets below the nutritional danger line.

In studying the iron content of vegetables grown in the home gardens of the children of the different districts, turnip greens were selected as an index food. Turnip greens are found in practically every garden and are perhaps the most important source of iron. All the samples collected for analysis had been fertilized with commercial fertilizer and were healthy, leafy plants typical of the variety. Analysis showed that the iron in these greens varied from 258 p.p.m. when grown on the protected soils to 56 p.p.m. when grown on the deficient ones. It is realized that in a diet made up of many iron-carrying foods, the differences in the iron content of turnip greens would be of minor importance. But to rural people depending almost entirely on home-grown vegetables for iron and using turnip greens the year round, the variation in the iron in these greens is one of considerable importance.

Through cooperation with the horticulturists of the several substations in the State, turnip greens from a uniform seed source were grown at four diverse points in Florida. The fertilizer practices of each section were used, but all plantings and cultural practices were the same. The greens produced were dissimilar in growth habit, leaf form, succulence, and mineral content. The average iron from the above-mentioned locations varied from 84 p.p.m. to 238 p.p.m.

Mustard greens likewise varied in iron in the different sections of the State from 60 p.p.m., when grown in certain sections, to 234 p.p.m., when grown on the heavy clays of west Florida. It must be borne in mind that none of the soils whereon these greens were grown was considered deficient, yet there was a considerable variation in iron.

A study was then made of the foods actually eaten by the farm families. In county 3 there are 240 farm families. It was considered that food samples collected from 80 of these families would be representative of the group. These samples consisted of an accurate duplication of all foods used in six consecutive meals by a child selected from each of the 80 families. In collecting the samples, the collector served an extra plate at each of the six meals with an amount of food equal to that eaten by the child. To this sample were added foods eaten between meals. These samples were collected from each family during the spring, summer, and winter. The foods were separated into those classed as predominatly protein, carbohydrate, or fat. Each food group was weighed separately.

It was found that in the amounts eaten, the iron content of the food samples from children having diets below the physiological danger line varied from 1.2 to 4 mg. daily; food samples from children in families producing their food on soils classed as marginal or deficient in regard to salt-sick varied from 3 to 6 mgs.; those from children whose food was produced on the better soils and was fairly adequate both as to quantity and quality varied from 6 to 10 mgs.

That the anemic condition of the children was due to mineral deficiency was demonstrated by treating 400 anemic children with 100 mgs. Fe as ferric ammonium citrate three times a day. Within 4 to 6 weeks after beginning treatment all the subjects showed improvement and all except the ones with very low hemoglobin had values within the normal range.

Because of the improvement in hemoglobin with the administration of iron salts, it is not to be assumed that iron was the only element involved. The ferric ammonium citrate was in the form of U. S. P. green scales and had copper, manganese, and cobalt as impurities. However, with the regeneration and restoration of hemoglobin there was a tremendous improvement in color, activity, and appetite.

It should be made clear that deficient soils and mineral deficiency diseases are not localized in small areas in Florida, neither are they confined to Florida. Deficient soils and mineral deficiency diseases of cattle have been identified in Nova Scotia, Massachusetts, North and South Carolina, Georgia, and Florida. Anemia of children is so widespread that it has often been called the ubiquitious nutritional disease.

In addition to the mineral deficiencies already noted, areas deficient in manganese, calcium, phosphorus, copper, and zinc have been identified. The effects of a lack of these elements on plants growing in those areas is well recognized, but the effects of a lack of some of these elements on animal nutrition are not known; neither is it known what effect slight deficiencies of these elements will have when extended over a long period.

From this work it seems evident that while hookworm infection undoubtedly affects the degree of anemia, the high incidence in rural children is due primarily to diets low in iron. These low iron diets are occasioned not only by low incomes, ignorance of food values, habit, inertia, but, as shown in this study, by variation in home-grown foods. It appears then that soil deficiency operating through the plants grown thereon and ultimately on the health of the people is a factor that should be considered in any section where nutritional anemia is endemic.